Future Fire Research in IRSN

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This presentation indicates first the IRSN strategy related to the fire research. Then the dominant fire scenarios that can occur in the French NPP and that need data from research to be assessed are presented. At last, IRSN needs in fire research are indicated.

Strategy of IRSN in fire research: The axes of research are mainly defined according to the safety assessment issues. The tight connection between expertise and research inside IRSN as well as the dialogue between utilities (such as COGEMA) and IRSN allow to fix clearly the priorities and the purposes of the research programs.

The research is divided into two complementary parts : experimental tests and modelling. The strong connection between the experiments and the modelling allows to develop and to assess the computer codes used to realise fire safety assessment. Two modelling approaches are developed: a simplified and empirical approach for fast and global safety assessment and a more detailed approach for more precise assessments in specific complex configurations. The experimental work is also composed of two parts: rather global, full scale, representative tests for getting direct information on specific configurations or equipments (the knowledge gained from this applied research can be directly used for safety analysis and for the global assessment of computer codes); analytical tests designed to improve the basic knowledge of the fire and help in models development and qualification.

The main objective of fire modelling is to provide well-qualified computer codes essential for performing safety assessment. Actually for this purpose the FLAMME-S code is used. For the future, the SYLVIA code will provide a set of models for simulating the fire development (two zone and CFD approaches), the ventilation network components behaviour and the aerosols (soot, radioactive materials) deposition and transfer between the rooms and through the ventilation network. Furthermore, the SYLVIA code will be coupled to the IRSN statistical tool, named SUNSET [5], thus allowing uncertainty propagation and sensitivity studies on code input data and model parameters. The main objectives of this new code development are to perform the coupling between all the main phenomena involved during a fire in a nuclear plant (fire propagation, ventilation behaviour, radioactive aerosols and soot transfers) and to provide different modelling

levels for various users (a simplified approach for fast-running calculations used for instance for PSA analyses; a detailed approach mainly for research activities).

Experimental programs in progress: IRSN is performing or is preparing 3 series of fire tests:

- FLIP test: these tests are related to TPB/TPH fire interacting with a wall in an confined and forced ventilated compartment,
- CARMELA test: these tests aim at providing knowledge of electrical cabinet fires. In a first test, analytical approach is implemented in order to understand the complex phenomena of electrical cabinet fires and notably the impact of some parameters (ventilation effect, spatial arrangement, cabinet filling, effect of the ignition location, quantity of combustible). In a second step, tests will be performed in a real electrical cabinet in order to study the consequences of such a fire notably on adjacent electrical cabinets and generation of inadvertent order,
- DIVA tests: this program firstly aims at studying all the consequences a fire, located in a room, has on neighbouring rooms and on the ventilation network: thermal propagation, smoke and fire spread, consequences of the fire on the ventilation and room equipments, management of the ventilation during a fire. For this program a new large-scale experimental facility has been built. It consists of three rooms (L=6m, l=5m, h=4m), a common corridor connecting these rooms, a room located above the third room and the neighbouring area of the corridor. The rooms are connected by a ventilation network and openings such as doors.

Fire scenarios selected: The fire scenarios that need research in order to improve the fire risk assessment have been identified by IRSN personal that is involved in safety assessment. These fire scenarios have been ranked to focus the fire research on dominant needs. For NPP, the fire scenarios selected are:

- an electrical cable fire induced by a fixed or transient combustible fire,
- a fire on a process control relay rack in a relay room,
- an electrical cabinet fire,
- a fire propagation to a compartment located above,

- a fire in a containment (unconfined fire),
- a fire in a benchboard of the control room.

IRSN fire research needs: Basic research topics are clearly identified by IRSN in order to improve the knowledge and modelling of the complex phenomena involved in fire scenarios.

For the fire study, the topics are:

- ✓ combustion parameters,
- ✓ soot production,
- ✓ improvement of the plume model in a confined and ventilated configuration,
- ✓ explosion hazards due to the non-burnt residues,
- ✓ fire propagation towards other fire sources,
- ✓ criteria for the failure of equipment and the electric cables.

A complementary research program is conducted for the transfer of radioactive aerosols inside a plant (including the ventilation network) and for the behaviour of the ventilation and confinement devices submitted to the thermo-mechanical stresses induced by a fire. The topics selected are, for example:

- ✓ Plugging of the filters by the aerosols of combustion,
- ✓ Setting up the suspension of radio-elements in the event of a fire,
- ✓ Mechanical resistance of the filters,
- ✓ Evolution of the aerosols of combustion outside the flame.

A first fire research program has been defined for the 3 first topics (combustion parameter, soot production, improvement of the plume model). This program that foresees to begin the research related to the combustion parameter in 2003 will be proposed in the frame of the next budget.